



## PRACTICE OF EPIDEMIOLOGY

### Randomized Trial of Financial Incentives and Delivery Methods for Improving Response to a Mailed Questionnaire

Michele Morin Doody<sup>1</sup>, Alice S. Sigurdson<sup>1</sup>, Diane Kampa<sup>2</sup>, Kathleen Chimes<sup>3</sup>, Bruce H. Alexander<sup>2</sup>, Elaine Ron<sup>1</sup>, Robert E. Tarone<sup>1</sup>, and Martha S. Linet<sup>1</sup>

<sup>1</sup> Division of Cancer Epidemiology and Genetics, National Cancer Institute, National Institutes of Health, Department of Health and Human Services, Bethesda, MD.

<sup>2</sup> Division of Environmental and Occupational Health, University of Minnesota, Minneapolis, MN.

<sup>3</sup> Westat, Incorporated, Rockville, MD.

*Received for publication December 14, 2001; accepted for publication October 28, 2002.*

In a follow-up study, only 64% of 126,628 US radiologic technologists completed a questionnaire during 1994–1997 after two mailings. The authors conducted a randomized trial of financial incentives and delivery methods to identify the least costly approach for increasing overall participation. They randomly selected nine samples of 300 nonresponders each to receive combinations of no, \$1.00, \$2.00, and \$5.00 cash or check incentives delivered by first-class mail or Federal Express. Federal Express delivery did not achieve greater participation than first-class mail (23.2% vs. 23.7%). In analyses pooled across delivery methods, the response was significantly greater for the \$2.00 bill (28.9%, 95% confidence interval (CI): 25.2, 32.7;  $p < 0.0001$ ), \$5.00 check (27.5%, 95% CI: 22.5, 33.0;  $p = 0.0001$ ), \$1.00 bill (24.6%, 95% CI: 21.2, 28.3;  $p = 0.0007$ ), and \$2.00 check (21.8%, 95% CI: 18.5, 25.3;  $p = 0.02$ ) compared with no incentive (16.6%, 95% CI: 13.7, 19.9). The response increased significantly with increasing incentive amounts from \$0.00 to \$2.00 cash ( $p$  trend  $< 0.0001$ ). The \$2.00 bill achieved a 30% greater response than did a \$2.00 check ( $p = 0.005$ ). For incentives sent by first-class mail, the \$5.00 check yielded 30% greater participation than did the \$2.00 check ( $p = 0.07$ ). A \$1.00 bill, chosen instead of the \$2.00 bill because of substantially lower overall cost and sent by first-class mail to the remaining 42,717 nonresponders, increased response from 64% to 72%.

cohort studies; data collection; epidemiologic methods; motivation; nonresponse; postal service; questionnaires; randomized controlled trials

Abbreviation: CI, confidence interval.

Postal questionnaires are often the only economically feasible alternative for obtaining information in epidemiologic studies (1). Response to mailed questionnaires varies according to population characteristics, the number of times subjects are approached, the content and wording of questions, and questionnaire length (2). Low response rates can threaten study validity (3–8) by introducing a selection bias

if nonresponse is disproportionate. A small monetary incentive has been shown to significantly improve response (9–22). To improve response among nonresponders of a questionnaire mailed to a nationwide cohort at lowest cost, we conducted a randomized trial to compare simultaneously nine different combinations of incentive amount, type, and delivery method.

Correspondence to Michele M. Doody, Radiation Epidemiology Branch, National Cancer Institute, Executive Plaza South, Room 7088, Bethesda, MD 20892-7362 (e-mail: doodym@exchange.nih.gov).

## MATERIALS AND METHODS

In 1982, the National Cancer Institute and the University of Minnesota initiated a cohort investigation to estimate cancer risk among approximately 146,000 radiologic technologists first certified by the American Registry of Radiologic Technologists between 1926 and 1982. The study flow chart is shown in figure 1. A structured questionnaire was sent during 1984–1987 by US first-class mail; 90,305 of 132,454 (68 percent) technologists who were presumed to be alive because of their having recertified with the American Registry of Radiologic Technologists within the previous year or having failed to link with national death record databases responded, providing information on prior cancers and selected other diseases, lifetime work history as a radiologic technologist, procedures performed, equipment used, and potential confounding factors (23). In a second follow-up, mailed questionnaires were sent during 1995–1997 to all 126,628 subjects who were presumed alive. We again inquired about all physician-diagnosed cancers, other medical conditions, employment, and cancer risk factors. By 1997, 64 percent had responded to the second survey following two questionnaire-mailing waves. We initiated a telephone follow-up of the 45,576 nonresponders; however, because of the magnitude of this effort, we later focused on the subgroup of 19,807 technologists who had responded to the first survey. We contacted 31 percent of all nonresponders; for 15 percent interviewers spoke directly with the subject, for 10 percent they left messages with family members, and for 6 percent they left messages on answering machines. The low participation led us to initiate a randomized trial to identify a cost-effective method for improving questionnaire completion among nonresponders. The randomized trial of financial incentives was approved by the institutional review boards at the National Cancer Institute and the University of Minnesota.

We randomly selected nine samples with 300 nonresponders each and then updated vital status and contact information. A few subjects in each group were deceased, could not be located, or responded to the questionnaire after they were selected but before the trial began; these subjects were excluded. There were no statistically significant differences among the nine groups in demographic characteristics and the number of years certified as a radiologic technologist (table 1). Telephone contact rates did not differ significantly among incentive groups (data not shown). We compared financial incentives of \$1.00 cash, \$2.00 cash or check, and \$5.00 check, as well as delivery by US first-class mail or Federal Express (Memphis, Tennessee). We did not test a \$1.00 check, which might be perceived as a nuisance, nor did we test a \$5.00 cash incentive or check sent by Federal Express, because these were not economically feasible incentives. Thus, compared with a referent group who received a questionnaire sent by US first-class mail with no financial incentive, eight different combinations of incentive type, amount, and method of delivery were evaluated (table 2).

All randomized nonresponders were included in the analysis whether they had a street address or a post office box (i.e., analysis was by intent to treat). Subjects who were

assigned to receive a questionnaire by first-class mail were prompted by a prenotification letter because the questionnaire was mailed in the same color and size of envelope that was used in the two previous mailings. No advance letter was sent if questionnaires were sent by Federal Express. Regardless of the delivery method, we included a postscript on the questionnaire's cover letter to draw attention to the enclosed monetary incentive and a letter supporting the study from the American Society of Radiologic Technologists. Questionnaires returned by the postal service or Federal Express with forwarding addresses were remailed; subjects with post office addresses that could not be delivered by Federal Express were counted as nonresponders. The percentages of questionnaires that were undeliverable ranged from 1.0 percent to 3.0 percent for incentives sent by first-class mail and from 2.0 percent to 6.4 percent for incentives sent by Federal Express.

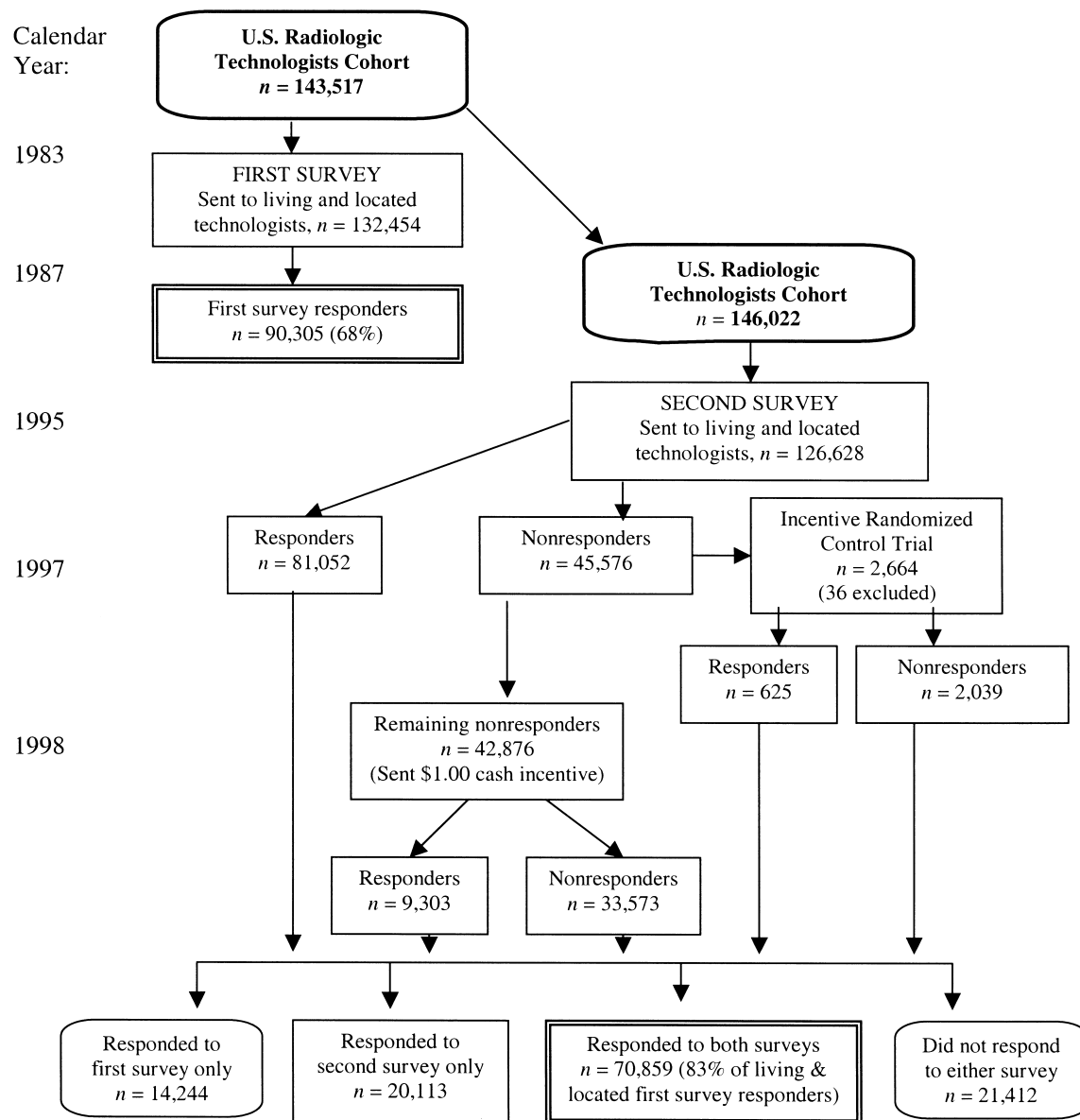
We used chi-square tests to evaluate the overall differences in response of the various groups compared with the referent group and to evaluate the demographic differences in response within incentive groups (e.g., men vs. women among those who were sent a \$1.00 bill) and among demographic categories between incentive groups (e.g., women who received a \$1.00 bill vs. women who received no incentive). We also evaluated check-cashing behavior according to the amount (\$2.00, \$5.00) of the check and the questionnaire response (no, yes). The Bonferroni method was used to assess possible chance findings associated with multiple comparisons (i.e., by multiplying each *p* value of <0.05 by the number of different incentives).

We calculated the costs per mailing and response for the incentive groups. We used the incentive trial findings to project the response rates and costs for a final mailing to the 43,000 remaining nonresponders, and we present response rates for the final mailing.

## RESULTS

Features of the 126,628 presumed living technologists targeted for the second survey were generally similar to those of the subset of 45,576 nonresponders to two questionnaire mailings, including attained age, geographic residence, and number of years certified as a radiologic technologist (data not shown). Male technologists were disproportionately represented among nonresponders (31 percent) compared with the second survey-eligible group (21 percent), as were baseline survey nonresponders (57 percent vs. 33 percent).

Compared with that of the referent group (response, 15.5 percent), response rates were 10–90 percent higher among the various incentive-delivery groups (table 2). Statistically significant improvements in response were seen for all cash incentives, regardless of the delivery method, and for the \$5.00 check sent by first-class mail and the \$2.00 check sent by Federal Express; Federal Express delivery without any incentive and a \$2.00 check sent by first-class mail did not significantly improve response. Because Federal Express delivery did not improve response rates over comparable incentives sent by first-class mail (23.2 percent vs. 23.7 percent, respectively), we pooled the results by delivery



**FIGURE 1.** Diagram of the target population of radiologic technologists as of the first and second survey mailings and the number of questionnaire responses, US Radiologic Technologists (USRT) Study, 1983–1998. The USRT cohort was initially established in 1982 and included 143,517 technologists who were certified by the American Registry of Radiologic Technologists for at least 2 years during 1926–1982. An additional 2,505 eligible technologists were later identified and added, bringing the total cohort to 146,022 technologists. As of the first survey, 6,350 technologists were deceased; as of the second survey, an additional 5,377 technologists were deceased, including 3,104 who completed the first survey.

method. As shown in table 3, compared with no incentive (16.6 percent response, 95 percent confidence interval (CI): 13.7, 19.9), significant improvements in response were seen with all of the pooled amount/type incentives. The \$2.00 bill yielded the best response (28.9 percent, 95 percent CI: 25.2, 32.7;  $p < 0.0001$ ), followed by the \$5.00 check (27.5 percent, 95 percent CI: 22.5, 33.0;  $p = 0.0001$ ), \$1.00 bill (24.6 percent, 95 percent CI: 21.2, 28.3;  $p = 0.0007$ ), and \$2.00 check (21.8 percent, 95 percent CI: 18.5, 25.3;  $p = 0.02$ ). The association for the \$2.00 check became nonsignificant ( $p =$

0.10), however, following adjustment for multiple comparisons. Only completed questionnaires were counted as a response.

The response increased significantly with increasing incentive amounts from \$0.00 to \$2.00 cash ( $p$  trend  $< 0.0001$ ). The \$2.00 bill achieved a statistically significant 30 percent greater response than a \$2.00 check ( $\chi^2 = 7.81$ ;  $p = 0.005$ ). For incentives sent by first-class mail, there was a 30 percent improvement for the \$5.00 check compared with the \$2.00 check ( $\chi^2 = 3.21$ ;  $p = 0.07$ ).

**TABLE 1. Characteristics of radiologic technologists included in a randomized trial of financial incentives and delivery methods for improving questionnaire response, by incentive group, US Radiologic Technologists Study, 1997–1998\***

Characteristic	US first-class mail					Federal Express				Chi square ( <i>p</i> value)
	None (referent)	\$1.00 bill	\$2.00 bill	\$2.00 check	\$5.00 check	None	\$1.00 bill	\$2.00 bill	\$2.00 check	
No. of eligible subjects†	297	294	296	297	298	298	296	293	295	2,664
Gender										
Female	68.4	66.0	69.3	74.4	66.8	68.5	66.9	65.9	70.9	
Male	31.7	34.0	30.7	25.6	33.2	31.5	33.1	34.1	29.2	0.41
Race										
White	81.1	82.0	79.1	83.5	81.9	82.6	85.8	84.6	84.4	
Black	6.4	7.5	10.1	6.1	6.7	5.7	6.1	7.5	6.4	
Other or unknown	12.5	10.5	10.8	10.4	11.4	11.7	8.1	7.9	9.2	0.65
Attained age (years)										
<40	18.9	18.7	18.6	17.2	21.5	19.5	18.9	20.1	18.0	
40–49	49.8	48.3	49.3	52.5	44.6	52.0	44.6	47.1	54.9	
50–59	17.9	19.1	20.6	18.5	21.1	18.8	26.0	22.9	19.7	
60–69	10.1	9.5	7.1	6.1	8.4	5.0	7.1	7.9	4.4	
≥70	3.4	4.4	4.4	5.7	4.4	4.7	3.4	2.1	3.1	0.35
Geographic region‡										
Northeast	26.9	27.6	23.0	25.9	26.2	25.2	21.0	20.8	25.4	
Midwest	21.6	22.8	23.7	24.2	22.2	22.8	28.4	28.7	23.7	
South	35.0	33.0	31.4	33.7	33.6	33.6	33.5	31.4	29.5	
West	16.5	16.7	22.0	16.2	18.1	18.5	17.2	19.1	21.4	0.69
No. of years certified										
<10	4.7	5.8	8.8	7.1	7.7	6.7	5.4	6.1	9.5	
10–19	36.7	37.8	36.8	33.7	35.2	36.6	34.5	39.9	35.9	
20–29	42.4	36.4	35.8	41.4	37.6	42.3	39.2	36.5	38.0	
≥30	16.2	20.1	18.6	17.9	19.5	14.4	21.0	17.4	16.6	0.67
Completed first survey§										
No	57.6	57.5	58.1	58.6	59.4	57.1	56.4	59.0	57.6	
Yes	42.4	42.5	41.9	41.4	40.6	43.0	43.6	41.0	42.4	>0.99

\* With the exception of the first row, the values in the table are percentages; some columns do not add to 100 percent because of rounding.

† The values in each category differ from the 300 selected to exclude those who were deceased (total, *n* = 29), responded before the trial began (*n* = 5), or were lost to follow-up (*n* = 2); subjects with undeliverable addresses (*n* = 82) were included to assess the efficacy of the delivery method.

‡ US Census Bureau definition: Northeast (Connecticut, Maine, Massachusetts, New Hampshire, Rhode Island, Vermont, New Jersey, New York, Pennsylvania, Delaware, Washington, DC, Maryland); Midwest (Illinois, Indiana, Michigan, Ohio, Wisconsin, Iowa, Kansas, Minnesota, Missouri, Nebraska, North Dakota, South Dakota); South (Florida, Georgia, North Carolina, South Carolina, Virginia, West Virginia, Alabama, Kentucky, Mississippi, Tennessee, Arkansas, Louisiana, Oklahoma, Texas); and West (Arizona, Colorado, Idaho, Montana, Nevada, New Mexico, Utah, Wyoming, Alaska, California, Hawaii, Oregon, Washington).

§ Baseline survey conducted during 1984–1987.

Responses by demographic characteristics (i.e., *within* incentive group comparisons) are shown in table 3. Men and women responded similarly to all incentives, except for a 50 percent greater response by women to the \$5.00 check. The number of non-White persons was small, but statistically significant differences were apparent by race within all incentive groups; Blacks typically responded at a much lower rate than did Whites, and persons in the “other” racial category responded especially poorly. There were no statistically significant differences in response by age, although technologists who were 60–69 years of age responded espe-

cially well to the \$5.00 check (52.0 percent). Responses to the various incentives did not vary significantly among the four major US Census-defined geographic regions of residence (North, South, Midwest, West); however, among the nine smaller Census-defined geographic divisions, especially low response rates were seen within the no incentive group in the Middle Atlantic (10.0 percent), East North Central (5.3 percent), and West South Central (10.4 percent) divisions (data not shown). The number of years a technologist was certified did not significantly influence the response to any of the incentives. Persons participating in the first

**TABLE 2. Results of randomized trial of financial incentives and delivery methods for improving questionnaire response among radiologic technologists, US Radiologic Technologists Study, 1997–1998**

Delivery method and incentive	No. of eligible subjects†	% who responded	% who cashed checks	Cost/ mailing (\$)‡	Cost/ response (\$)§
US first-class mail					
None (referent)	297	15.5		4.70	29.10
\$1.00 bill	294	25.2**		6.64	25.50
\$2.00 bill	296	29.1***		7.64	25.09
\$2.00 check	297	21.2	24.2	6.29	29.65
\$5.00 check	298	27.5***	34.2	7.52	27.33
Federal Express					
None	298	17.8		7.60	37.61
\$1.00 bill	296	24.0**		9.32	36.02
\$2.00 bill	293	28.7***		10.32	32.11
\$2.00 check	295	22.4*	26.8	9.03	40.36
Total	2,664	23.5	28.4		

\*  $p < 0.05$ ; \*\*  $p < 0.01$ ; \*\*\*  $p < 0.001$  in chi-square tests comparing incentive groups with first-class/no-incentive (referent) group.

† The numbers in each category differ from the 300 selected to exclude those who were deceased (total,  $n = 29$ ), responded before the trial began ( $n = 5$ ), or were lost to follow-up ( $n = 2$ ); values include subjects with undeliverable addresses ( $n = 82$ ) to assess the efficacy of the delivery method.

‡ The cost per questionnaire sent includes materials and labor for advance letters (questionnaires sent by US Postal Service only), delivery fees (US Postal Service or Federal Express), and incentive amount, and it is adjusted for savings from uncashed checks  $(([\text{no. of subjects} \times \text{maximum estimated cost}] - [\text{no. of uncashed checks} \times \text{check amount}]) / \text{no. of subjects})$ .

§ The cost per response =  $(\text{no. of questionnaires sent} \times \text{the actual cost per mailing}) / \text{the no. of responses}$ .

survey were significantly more likely to respond to the second survey (ranging from 40 percent (\$5.00 check) to 2.4 times (\$2.00 check) higher than those who did not respond to the first survey).

Between-group differences (i.e., response to specific incentives vs. no incentive) were also seen according to demographic characteristics (table 3). Compared with their counterparts who received no incentive, men who received a \$1.00 or \$2.00 bill and women who received a \$2.00 bill or \$5.00 check were significantly more likely to respond. Significant improvements in response were seen for Whites with all but the \$2.00 check and for persons in the "other" racial category with the \$2.00 bill. The small number of Black respondents made differences in response across incentives difficult to interpret. The \$2.00 bill afforded substantial and, in most cases, statistically significant improvements in response among all technologists 40 or more years of age and improved response regardless of the number of years the technologist was certified. Significant improvements in response were seen for the \$2.00 bill in the Midwest and South Census geographic regions and for the \$2.00 check in the Midwest. The \$1.00 bill was effective in all but the West region, while the \$5.00 check improved response in all regions; note, however, that these associations were not statistically significant after adjusting for multiple comparisons. Although based on small numbers, residents of the East South Central Census division, which encompasses much of Appalachia, responded very favorably to cash incentives of \$1.00 (41.9 percent;  $n = 14$ ) and \$2.00

(45.2 percent;  $n = 14$ ) (data not shown). All incentives significantly improved response among the first survey responders, although the association with the \$5.00 check was not significant after adjustment for multiple comparisons; however, only the \$2.00 bill and the \$5.00 check prompted significant increases among nonresponders to the first survey.

Among individuals who were sent checks, in general, 89.6 percent of those who responded to the questionnaire cashed their checks, while only 9.4 percent of those who did not respond cashed their checks (table 4). Both responders and nonresponders were more likely to cash the \$5.00 check than the \$2.00 check. Within groups defined by the second survey response and demographic characteristics, there were no significant differences in check-cashing behavior (data not shown).

For questionnaires sent by first-class mail, the cost per questionnaire returned was lowest for the \$2.00 bill (\$25.09) and highest for the \$2.00 check (\$29.65) (table 2). The cost per response for the \$1.00 bill (\$25.50) was similar to that for the \$2.00 bill. Use of Federal Express delivery added costs of about \$8.50 per response.

Use of any of the incentive amount/type/delivery combinations with the remaining 43,000 nonresponders was projected to achieve an overall response greater than 70 percent among those eligible for the second survey. We opted to send a final questionnaire by first-class mail with a \$1.00 cash incentive. This method was the second most effi-

**TABLE 3. Number of radiologic technologists included in the financial incentive trial and the percentage who responded, by personal characteristics and amount and type of financial incentive, US Radiologic Technologists Study, 1997–1998**

Characteristic	No incentive (referent)		\$1.00 bill		\$2.00 bill		\$2.00 check		\$5.00 check	
	No. responded	%	No. responded	%	No. responded	%	No. responded	%	No. responded	%
Total (no. responded/no. eligible)	99/595	16.6	145/590	24.6***	170/589	28.9***	129/592	21.8*,†	82/298	27.5***
Gender										
Male	26	13.8	53	26.8**	58	30.4***	35	21.6	21	21.2
Female	73	17.9	92	23.5	112	28.1***	94	21.9	61	30.7***
<i>p</i> value		(0.21)‡		(0.38)		(0.58)		(0.95)		(0.09)
Race										
White	93	19.1	134	27.1**	155	32.2***	119	23.9	76	31.2***
Black	5	13.9	7	17.5	8	15.4	9	24.3	4	20.0
Other/unknown	1	1.4	4	7.3	7	12.7**	1	1.7	2	5.9
<i>p</i> value		(0.0008)		(0.003)		(0.0009)		(0.0005)		(0.006)
Attained age (years)										
<40	19	16.7	27	24.3	29	25.4	23	22.1	18	28.1
40–49	53	17.5	72	26.3*	81	28.5**	63	19.8	31	23.3
50–59	19	17.4	30	22.6	35	27.3	28	24.8	16	25.4
60–69	5	11.1	12	24.5	16	36.4**	9	29.0*,†	13	52.0***
≥70	3	12.5	4	17.4	9	47.4*	6	23.1	4	30.8
<i>p</i> value		(0.83)		(0.85)		(0.27)		(0.68)		(0.06)
Geographic region§										
Northeast	24	15.5	37	25.9*,†	28	21.7	35	23.0	20	25.6
Midwest	14	10.6	32	21.2*,†	42	27.3***	32	22.5**	15	22.7*,†
South	40	19.6	55	28.1*,†	62	33.5**	34	18.2	27	27.0
West	21	20.2	21	21.0	38	31.4	28	25.2	20	37.0*,†
<i>p</i> value		(0.12)		(0.39)		(0.13)		(0.50)		(0.34)
No. of years certified										
<10	2	5.9	3	9.1	10	22.7*,†	7	14.3	3	13.0
10–19	32	14.7	50	23.5*,†	60	26.6**	42	20.4	27	25.7*,†
20–29	46	18.3	57	25.6	65	30.5**	55	23.4	30	26.8
≥30	19	20.9	35	28.9	35	33.0	25	24.5	22	37.9*,†
<i>p</i> value		(0.17)		(0.12)		(0.46)		(0.45)		(0.12)
Completed first survey¶										
No	43	12.6	59	17.6	83	24.1***	47	13.7	42	23.7**
Yes	56	22.1	86	33.9**	87	35.7***	82	33.1**	40	33.1*,†
<i>p</i> value		(0.002)		(<0.0001)		(0.002)		(<0.0001)		(0.08)

\*  $p < 0.05$ ; \*\*  $p < 0.01$ ; \*\*\*  $p < 0.001$  in chi-square tests comparing incentive groups with first-class/no-incentive (referent) group.

† Not significant ( $p \geq 0.05$ ) after the Bonferroni correction for multiple comparisons (i.e., each chi-square  $p$  value was multiplied by 4 to adjust for the number of incentive groups compared with the no-incentive referent group).

‡ Numbers in parentheses are  $p$  values for chi-square tests of homogeneity within strata, excluding subjects with unknown values.

§ US Census Bureau definition: Northeast (Connecticut, Maine, Massachusetts, New Hampshire, Rhode Island, Vermont, New Jersey, New York, Pennsylvania, Delaware, Washington, DC, Maryland); Midwest (Illinois, Indiana, Michigan, Ohio, Wisconsin, Iowa, Kansas, Minnesota, Missouri, Nebraska, North Dakota, South Dakota); South (Florida, Georgia, North Carolina, South Carolina, Virginia, West Virginia, Alabama, Kentucky, Mississippi, Tennessee, Arkansas, Louisiana, Oklahoma, Texas); and West (Arizona, Colorado, Idaho, Montana, Nevada, New Mexico, Utah, Wyoming, Alaska, California, Hawaii, Oregon, Washington).

¶ Baseline survey conducted during 1984–1987.

cient in cost per response and had the next to lowest overall cost (only the \$2.00 check was lower). We sent letters in advance to notify the prior nonresponders that a small token of our appreciation would be included with a forthcoming questionnaire. We received 9,303 additional responses, bringing the final response rates to 72 percent overall and 83 percent among first survey responders. The response to the final mailing was similar for men and women, higher among Whites, and higher among first survey responders; the

response was lower among technologists who were 70 or more years of age and among those certified for less than 10 years (data not shown). There was little difference in response by geographic residence.

## DISCUSSION

Our randomized trial revealed that a small monetary incentive was effective in converting a number of reluctant

**TABLE 4. Check-cashing behavior among radiologic technologists according to questionnaire response status and amount of check, US Radiologic Technologists Study, 1997–1998**

Cashed check by check amount	Questionnaire response			
	No		Yes	
	No.	%	No.	%
\$2.00 check				
No	425	91.8	16	12.4
Yes	38	8.2	113	87.6
\$5.00 check				
No	190	88.0	6	7.3
Yes	26	12.0	76	92.7
Any check				
No	615	90.6	22	10.4
Yes	64	9.4	189	89.6

responders. Cash yielded a significantly better response than did checks, and the response increased significantly with increasing incentive amounts (\$0.00, \$1.00, \$2.00). The \$2.00 bill, perhaps because of its novelty, achieved the best response. We found no advantage to using the more expensive Federal Express delivery method over first-class mail.

Compared with previous randomized trials of financial incentives (1, 10–22, 24–26) and methods of questionnaire delivery (12, 18, 22, 27, 28), our study had several unique features. We simultaneously compared nine combinations of incentive amount and type, as well as delivery methods, whereas previous studies generally compared from two to six approaches. This is one of the first studies to directly compare responses to cash vs. check incentives of the same amount, to evaluate check-cashing behavior by the amount of the check, and to assess geographic differences in the response and cost per questionnaire returned by incentive amount and type. Finally, we describe the final outcome among the remaining 43,000 nonresponders in this nationally distributed US cohort.

Strategies shown to improve response in previous studies include the use of first-class mail (10, 12), certified mail with a return receipt (12, 18, 27, 28), stamped envelopes (12), personalized mail-out packages (27, 29), short questionnaires (12), monetary incentives from \$1.00 to \$50.00 (12, 13, 17, 18, 20, 30–38), prenotification and follow-up mailings (10), colored questionnaires (especially green) (10), university sponsorship (10), lotteries (19, 39, 40), Federal Express delivery (22), and commemorative stamps (41). Prepayments of financial incentives have generally resulted in better responses than promises of postpayment (11, 13, 16, 42). A systematic review of the effectiveness of these methods was recently published (43). Caution in the use of incentives may be warranted in studies with repeated surveys; one study reported that the response to a second survey sent without an incentive was lower for subjects who received an incentive with the initial questionnaire than for those who did not (34).

Our findings for small cash or check incentives (\$1.00, \$2.00, \$5.00) resemble the results reported by others (13, 17, 18, 20, 30–38), although a higher response to cash than checks has not been previously noted. We identified only one other study that compared Federal Express with US first-class mail delivery (22); the authors reported a significantly greater response among a small group of physicians sent questionnaires by Federal Express. The lack of improvement with Federal Express observed in our study may reflect the use of prenotification letters with questionnaires sent by first-class mail but not with questionnaires sent by Federal Express.

Consistent with previous reports (14–16, 18, 21, 26, 32), we found little difference in response by gender or attained age. Although the numbers of non-Whites were small in each incentive group, the significant difference in response by race within our nationally distributed cohort contrasts with a lack of difference among cosmetologists in North Carolina (15). The higher response by first survey responders compared with nonresponders is consistent with a previous study (16), although our finding may reflect a more intensive prior effort to telephone first survey responders. We did not find other US reports evaluating various incentives in relation to geographic residence.

The overall response (21.8 percent) of the 43,000 nonresponders to the final mailing of a questionnaire with a \$1.00 bill was lower than projected for the \$1.00 bill in the incentive trial (24.6 percent). Demographic patterns in response to the final mailing were not inconsistent with those in the incentive trial, although less variation was seen across geographic divisions than was observed in the much smaller incentive trial sample.

The most effective incentive was the \$2.00 bill. The “novelty” of the bill, rather than the amount, is the likely reason for its success (18, 34, 36). It was not economically feasible to assess a \$5.00 bill, which has outperformed the \$2.00 bill in other studies (33, 37). The \$2.00 check, which was least effective, may have been viewed as more of a nuisance to deposit rather than a gesture of appreciation. Our finding that responders generally cashed their checks and nonresponders did not is consistent with results from other studies (16, 44, 45). The smaller percentages of responders and nonresponders who cashed the \$2.00 checks versus the \$5.00 checks may reflect perceptions that the small amount was not worth the effort to cash. Our higher costs per response, compared with other reports for comparable incentives sent with a first mailing (18, 33, 37, 38), likely reflect the difficulty in increasing response among subjects who had not responded to two earlier mailings and, for some, a telephone prompt.

The limitations of our study included incomplete evaluation of all permutations of amount or type of incentive, as well as delivery method, and the potential lack of applicability of the findings beyond a predominantly female, medical worker cohort. Our data cannot address the effect of the prenotification letter, because we used it with questionnaires sent by first-class mail but not with those sent by Federal Express. Despite allocating 300 persons per arm, the generally low returns among persons not responding to two previous mailings limited the power to estimate differences

among certain age, gender, race, geographic, and other categories evaluated. Useful patterns may be suggested, but our results should be interpreted cautiously.

As suggested (14, 15, 20, 26), we conducted a randomized trial to test approaches for improving participation and then applied the findings in a cost-effective manner. The result was a notable improvement in the final participation rates. As information accumulates about individual and population differences in response to small incentive amounts/types and delivery methods, it may become possible to tailor cost-effective strategies for improving response rates for specific subpopulations. As response to mail solicitations continues to decline (46, 47), pilot trials to identify low-cost procedures to enhance participation may become increasingly important.

## REFERENCES

- Dillman DA. The design and administration of mail surveys. *Annu Rev Sociol* 1991;17:225-49.
- Tortora RD, Dillman DA, Rolstein R. Considerations related to how incentives influence survey response. Presented at a symposium on providing incentives to survey respondents, John F. Kennedy School of Government, Harvard University, October 1-3, 1992.
- Siemiatycki J, Campbell S. Nonresponse bias and early versus all responders in mail and telephone surveys. *Am J Epidemiol* 1984;120:291-301.
- Heilbrun LK, Nomura A, Stemmermann GN. The effects of non-response in a prospective study of cancer: 15 year follow-up. *Int J Epidemiol* 1991;20:328-38.
- Wacholder S, McLaughlin JK, Silverman DT, et al. Selection of controls in case-control studies. I. Principles. *Am J Epidemiol* 1992;135:1019-28.
- Bisgard KM, Folsom AR, Hong CP, et al. Mortality and cancer rates in nonrespondents to a prospective study of older women: 5-year follow-up. *Am J Epidemiol* 1994;139:990-1000.
- Shahar E, Folsom AR, Jackson R. The effect of nonresponse on prevalence estimates from a referent population: insights from a population-based cohort study. *Ann Epidemiol* 1996;6:498-506.
- Etter JF, Perneger TV. Analysis of non-response bias in a mailed health survey. *J Clin Epidemiol* 1997;50:1123-8.
- Dillman D. Mail and telephone surveys: the total design method. New York, NY: John Wiley & Sons, Inc, 1978.
- Fox RJ, Crask MR, Kim J. Mail survey response rate: a meta-analysis of selected techniques for inducing response. *Public Opin Q* 1988;52:467-91.
- Church AH. Estimating the effects of incentives on mail response rates: a meta-analysis. *Public Opin Q* 1993;57:62-79.
- Kellerman SE, Herold J. Physician response to surveys: a review of the literature. *Am J Prev Med* 2001;20:61-7.
- Spry VM, Hovell MF, Sallis JG, et al. Recruiting survey respondents to mailed surveys: controlled trials of incentives and prompts. *Am J Epidemiol* 1989;130:166-72.
- Perneger TV, Etter JF, Rougemont A. Randomized trial of use of a monetary incentive and a reminder card to increase the response rate to a mailed health survey. *Am J Epidemiol* 1993;138:714-22.
- John EM, Savitz DA. Effect of a monetary incentive on response to a mail survey. *Ann Epidemiol* 1994;4:231-5.
- Schweitzer M, Asch DA. Timing payments to subjects of mail surveys: cost-effectiveness and bias. *J Clin Epidemiol* 1995;48:1325-9.
- Gilbart E, Kreiger N. Improvement in cumulative response rates following implementation of a financial incentive. *Am J Epidemiol* 1998;148:97-9.
- Gibson PJ, Koepsell TD, Diehr P, et al. Increasing response rates for mailed surveys of Medicaid client and other low-income populations. *Am J Epidemiol* 1999;149:1057-62.
- Kalantar JT, Valley NJ. The effects of lottery incentive and length of questionnaire on health survey response rates: a randomized study. *J Clin Epidemiol* 1999;52:1117-22.
- Parkes R, Kreiger N, James B, et al. Effects on subject response of information brochures and small cash incentives in a mail-based case-control study. *Ann Epidemiol* 2000;10:117-24.
- Collins RL, Ellickson PL, Hays RD, et al. Effects of incentive size and timing on response rates to a follow-up wave of a longitudinal mailed survey. *Eval Rev* 2000;24:347-63.
- Kasprzyk D, Montano DE, St Lawrence JT, et al. The effects of variations in mode of delivery and monetary incentive on physicians' responses to a mailed survey assessing STD practice patterns. *Eval Health Prof* 2001;24:3-17.
- Doody MM, Mandel JS, Lubin JH, et al. Mortality among U.S. radiologic technologists, 1926-1990. *Cancer Causes Control* 1998;9:67-75.
- Yammarino FJ, Skinner SJ, Childers TL. Understanding mail survey response behavior: a meta analysis. *Public Opin Q* 1990;55:613-39.
- Eaker S, Bergström R, Bergström A, et al. Response rate to mailed epidemiologic questionnaires: a population-based randomized trial of variations in design and mailing routines. *Am J Epidemiol* 1998;147:74-82.
- Hoffman SC, Burke AE, Helzlsouer K, et al. Controlled trial of the effect of length, incentives, and follow-up techniques on response to a mailed questionnaire. *Am J Epidemiol* 1998;148:1007-11.
- Rimm EB, Stampfer MJ, Colditz GA, et al. Effectiveness of various mailing strategies among non-respondents in a prospective cohort study. *Am J Epidemiol* 1990;131:1068-71.
- Del Valle ML, Morgenstern H, Rogstad TL, et al. A randomized trial of the impact of certified mail on response rate to a physician survey, and a cost-effectiveness analysis. *Eval Health Prof* 1997;20:389-406.
- Maheux B, Legault C, Lambert J. Increasing response rates in physicians' mail surveys: an experimental study. *Am J Public Health* 1989;79:638-9.
- Little RE, Davis AK. Effectiveness of various methods of contact and reimbursement on response rates of pregnant women to a mail questionnaire. *Am J Epidemiol* 1984;120:161-3.
- James JM, Bolstering R. Effect of monetary incentives and follow-up on the response rate and response quality in mail surveys. *Public Opin Q* 1990;54:346-61.
- Finlay J, Thistlethwaite PC. Applying mail response enhancement techniques to health care surveys: a cost-benefit approach. *Health Market Q* 1992;10:91-102.
- Asch DA, Christakis NA, Ubel PA. Conducting physician mail surveys on a limited budget. A randomized trial comparing \$2 bill versus \$5 bill incentives. *Med Care* 1998;36:95-9.
- Cotterchio M, Kreiger N. The effect of financial incentives on participation in future research. *Epidemiology* 1998;9:216.
- Hare S, Price JH, Glynn MG, et al. Increasing return rates of mail survey to exercise professionals using a modest monetary incentive. *Percept Mot Skills* 1998;86:217-18.
- Martinson BC, Lazovich D, Lando HA, et al. Effectiveness of monetary incentives for recruiting adolescents to an intervention trial to reduce smoking. *Prev Med* 2000;31:706-13.
- Shaw MJ, Beebe TJ, Jensen HL, et al. The use of monetary



- incentives in a community survey: impact on response rates, data quality, and cost. *Health Serv Res* 2001;35:1339–46.
38. Van Geest JB, Wynia MK, Cummins DS, et al. Effects of different monetary incentives on the return rate of a national mail survey of physicians. *Med Care* 2001;39:197–201.
39. Lykken DT, Bouchard TJ Jr, McGue M, et al. The Minnesota Twin Family Registry: some initial findings. *Acta Genet Med Gemellol (Roma)* 1990;39:35–70.
40. Baron G, De Wals P, Milord F. Cost-effectiveness of a lottery for increasing physicians' responses to a mail survey. *Eval Health Prof* 2001;24:47–52.
41. Choi BCK, Pak AWP, Purdham JT. Effects of mailing strategies on response rate, response time, and cost in a questionnaire study among nurses. *Epidemiology* 1990;1:72–4.
42. Rudy EB, Estok PJ, Kerr ME, et al. Research incentives: money versus gifts. *Nurs Res* 1994;43:253–5.
43. Edwards P, Roberts I, Clarke M, et al. Increasing response rates to postal questionnaires: systematic review. *BMJ* 2002;324:1183–5.
44. Fiset L, Milgrom P, Tarnal J. Dentist's response to financial incentives in a mail survey of malpractice liability experience. *J Public Health Dent* 1994;54:68–72.
45. Berk ML, Edwards WS, Gay NL. The use of a prepaid incentive to convert nonresponders on a survey of physicians. *Eval Health Prof* 1993;16:239–45.
46. Kessler RC, Little RJA, Goves RM. Advances in strategies for minimizing and adjusting for survey nonresponse. *Epidemiol Rev* 1995;17:192–204.
47. Slattery ML, Edwards SL, Caan BJ, et al. Response rates among control subjects in case-control studies. *Ann Epidemiol* 1995;5:245–9.